HELPING STUDENT TEACHERS LEARN TO NOTICE: A PRELIMINARY REPORT

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Noticing is important to skilled teaching, as it enables teachers to modify instruction in response to students' mathematical thinking and understanding. Novice teachers, however, often fail to notice important student ideas. A study was conducted with two secondary-level student teachers that focused on using research-like video analysis to help them learn to notice and assess the mathematical potential of important moments during instruction. Preliminary results of this work, as well as participants' perspectives on their learning, are discussed. This use of video analysis holds promise for helping novice teachers use their classroom as a site for inquiry and learning.

Objectives and Purposes of the Study

The vision of mathematics instruction advocated in documents such as the National Council of Teachers of Mathematics' [NCTM] *Standards* (e.g., 2000)—one in which teachers listen to and make sense of student ideas in order to build on them during instruction—requires a very different set of skills, dispositions and competencies than the traditional, teacher-centered model of instruction (Feiman-Nemser, 2001). It requires that teachers use the classroom as a site for inquiry and continued learning. Given the recognition that completing a teacher education program is not sufficient to develop all of the finished competencies of an effective teacher (Feiman-Nemser, 2001; Hiebert, Morris, & Glass, 2003), it has been suggested that it may be more productive to conceptualize teacher education as a venue for helping teachers acquire tools that enable them to learn from practice over time (Ebby, 2000), rather than as a site for producing a fully-formed teacher.

Tools to learn from practice can be developed through engaging with student thinking (Feiman-Nemser, 2001; Philipp, et al., 2007), but many opportunities to do so within teacher preparation programs are not capitalized upon. Traditional field experiences, for example, have been criticized for helping prospective teachers learn what is currently being done, rather helping them rethink the possibilities for instruction (e.g., Philipp, et al., 2007). Even when placed in exemplary classrooms, prospective teachers often do not have the knowledge or dispositions to meaningfully observe classroom interactions (Masingila & Doerr, 2002). Adding to the problem is the fact that the goals of field experiences are often not well-articulated, leaving school-based mentors to develop their own goals for the field experience that often have little connection to mathematical content or students' understanding of it (Leatham & Peterson, 2010). Thus, it is becoming recognized that intentional and substantial teacher educator involvement—visiting school sites and engaging teacher candidates in discussions about what is observed—is critical to supporting meaningful learning from field experiences (Grossman, et al., 2009; Masingila & Doerr, 2002).

The use of video is another promising method of positioning prospective teachers to continue to learn from practice as it grounds learning in practice. In fact, studies have found that video cases can support the development of teachers' analytical skills by helping them learn to make sense of students' mathematical ideas and use classroom-based evidence to support analyses of

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teaching and learning (Sherin & van Es, 2005; Author reference). Much of the current work with video, however, has used classroom video clips that have been selected and edited by experienced teacher educators, eliminating the opportunity for teachers to determine what instances might be worthy of analysis. This is problematic because in order to learn from teaching practice, teachers first need to *notice* (Sherin & van Es, 2005) important instructional events. In fact, a major difference between expert and novice teachers' practices is their ability to notice and respond to important instances during instruction (Hogan, Rabinowitz, & Craven, 2003), with novices failing to notice or act upon many instructional instances that experienced educators intuitively recognize and productively respond to (Peterson & Leatham, 2009). Thus, to position teachers to learn from practice, teacher educators need to not only develop prospective teachers' ability to analyze classroom events, but also their ability to notice the events that are worthy of analysis because of their potential to support students' mathematical learning.

Ongoing work has led to an initial conceptualization of important mathematical moments that teachers should attend to during instruction (e.g., Leatham, Peterson, Stockero, & Van Zoest, in press) and a characterization of circumstances likely to lead to such moments (e.g., Stockero, Van Zoest, & Taylor, 2010). This work is an important first step in making such moments visible to teachers, as it provides frameworks that can be used to scaffold teacher noticing by focusing their attention on characteristics of potentially fruitful mathematical moments that could be capitalized on during instruction. The study reported here aimed to develop a preliminary understanding of how such frameworks might be used in practice. In particular, the frameworks developed as part of related projects were used to inform the development and implementation of instructional activities aimed to help two prospective secondary school mathematics teachers learn to recognize and analyze important mathematical moments in instruction during their student teaching experience. In this paper, the teacher learning activities, data collection, and analysis are described, and the results of initial data analysis are shared. The paper concludes with a discussion of the potential implications of this work for teacher education and future directions of the work.

Theoretical Perspectives

Consistent with current thinking in mathematics education (i.e., NCTM, 2000), this research is based on the view that the use of student thinking is central to effective mathematics instruction. Thus, it follows that noticing important student mathematical thinking is an essential skill of effective mathematics teachers, since teachers cannot intentionally act upon that which they do not notice (Sherin & van Es, 2005). The definition of noticing used in this work draws on that of Sherin and van Es (e.g., Sherin & van Es, 2005; van Es & Sherin, 2002), who define noticing as comprised of three interrelated skills: identifying important events during instruction, reasoning about them, and making connections between the events and broader educational principles. The conceptualization of the act of noticing during instruction underlying the research is shown in Figure 1; the first two components are the focus of the part of the work reported here.

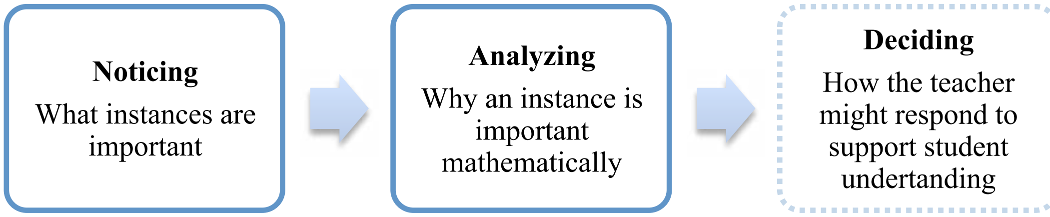

Figure 1. Components of teacher noticing.

The idea that student thinking is central to effective mathematics instruction does not imply that all student thinking is equally useful. Some student ideas, for example, are only tangentially related to the goals of the lesson or do not have the potential to add to students' understanding of important mathematical ideas. These ideas are probably not worthwhile to pursue during a lesson, as the benefit they would bring would not outweigh the time taken from the lesson. Other student ideas, however, are mathematically rich and provide an opportunity for the teacher to use the student thinking to develop important mathematical ideas (Author reference). These are the instances that were the focus of this study. The central component of noticing as used in this work was helping novice teachers learn to notice student thinking that has the potential to advance student understanding of important mathematical ideas, while not expending time and energy on that which does not.

Methodology

Participants

Two prospective secondary school teachers enrolled in the same teacher education program participated in the study during an 11-week student teaching experience. Both participants had been enrolled in a mathematics methods course taught by the researcher during the previous semester; an explicit focus of this course was on listening to and making sense of students' mathematical thinking in order to build on it during instruction. Both participants were working with two cooperating classroom teachers, one in their major content area and one in their minor; this is typical of students in the program. Mary was completing her student teaching in high school chemistry (major) and mathematics (minor) classrooms and Audrey in middle school mathematics (major) and science (biology minor) classrooms. Project activities focused only on the participants' mathematics classes. A graduate student research assistant (RA), an experienced teacher and Audrey's cooperating teacher for mathematics, assisted on the project. The RA had no previous experience with the type of research-like analysis of instruction that was the focus of the study and was explicitly asked not to discuss the project activities with Audrey outside of project meetings.

Context

To help them learn to notice and make sense of important mathematical instances during instruction, the participants used the Studiocode video analysis software (SportsTec, 1997-2011) as a tool to analyze video recordings of classroom instruction. This software was selected because it allows multiple users to individually code and annotate a video segment and then merge and compare coding among users. It was hypothesized that engaging participants in research-like video analysis, rather than in more open discussions of classroom video that have been typical in past video case research (e.g., Author reference), would enhance their ability to notice important mathematical moments during classroom instruction, as it required them to

individually code the video and justify their coding before they engaged in discussions about it.

The participants coded a total of eight classroom videos during the project. The first was of the RA's instruction during the second week of the student teaching experience when the participants were just beginning to take on teaching responsibilities. The remaining videos were recorded in Mary's and Audrey's classrooms, alternating between classrooms each week. After recording, the researcher prepared each video for analysis by editing out portions where audio could not be heard or that were not related to the lesson content; this was done to reduce the participants' video analysis time. It is important to note that the researcher did not edit any portion of the video where the teacher or students were talking about mathematics. The only portions what were edited were those where the teacher was taking care of administrative tasks or where students were working quietly.

The participants were instructed to code each video for *mathematically important moments* that would be important for a teacher to notice during instruction and to annotate each coded segment to indicate its perceived mathematical importance. The phrase *mathematically important moment* was intentionally left undefined by the researcher so that the group could refine the definition during project meetings. The participants first coded and annotated each video individually, after which they sent their Studiocode coding timeline to the researcher via email. The researcher and RA also individually coded the same video and then met to discuss their coding and agree upon the mathematically important moments in the video that a teacher could capitalize on during instruction. The researcher then compared these agreed-upon instances to those coded by the participants to determine which instances would be discussed in the next project meeting. The instances that were agreed upon by the researchers and both participants were always discussed during the meetings, with an emphasis on making sense of the mathematical importance of these moments. Instances that were coded by only one participant, or only by the researchers, were sometimes chosen to help distinguish instances that were mathematically important from those that were less important, or to highlight important mathematics embedded in student thinking.

The participants and the researcher met weekly for 60 to 90 minutes to view and discuss the coded video segments; the RA attended the first four meetings. During each meeting, the researcher pushed the participants to articulate the mathematical importance of instances they had identified and to consider whether there were characteristics common among mathematically important moments during instruction. For instance, the participants came to agree that student involvement seemed central to mathematically important moments, and thus, it was unlikely for such a moment to occur if students were not actively participating in the lesson.

During the last two weeks of the project, each participant taught a lesson in which she was asked to indicate her real-time noticing during instruction. This was done via a self-mounted camera that could be activated by the participant. The researcher also recorded the entire lesson. Following the lesson, each participant engaged in an interview that focused on the mathematically important moments that she had noticed during the lesson. The interview also included questions aimed at understanding participants' perspectives on the project activities and how these activities supported their learning during the student teaching experience.

Data Collection and Analysis

Data included participants' individual and merged Studiocode coding timelines and the accompanying video, the researchers' Studiocode timelines, and video recordings of each project meeting. In addition, video snapshots from the real-time noticing experience, the corresponding

complete classroom video, and a recording of the post-interview were also included in the data.

The first phase of data analysis focused on summarizing the instances in each video that participants coded as a mathematically important moment and making comparisons both between the two participants' coding and between the researchers' and the participants' coding. This analysis focused on documenting the segments that were coded as mathematically important, as well as the participants' reason for identifying them as such. In many cases, the participants did not give a complete explanation of the importance of an instance in their annotation, so were pushed for a more complete explanation during the project meeting. In these cases, information from both the Studiocode timeline and the project meeting video was used to develop a complete explanation of the perceived importance of the moment. The outcome of this phase of analysis was an account of participants' noticing and their explanations of the importance of the coded moments in each video. This gave preliminary information about how each changed over time.

The participant interviews were analyzed to understand the participants' perspectives on the learning activities themselves, the value of specific activities in terms of supporting their learning during student teaching, and what they perceived to have learned by engaging in the project activities.

Results

Evidence of Learning in Coding and Project Meetings

Preliminary data analysis indicates that there was a change in participants' abilities to notice and analyze mathematically important moments during the study. In the first video, both participants focused mainly on identifying "good teacher moves." For example, both coded instances in which the teacher used a good visual representation of a problem, asked a series of questions to ensure that students understood the rules of a probability game, and summarized the lesson at the end. In addition, Audrey noted several instances where the teacher clearly defined mathematical terms. Although these were all productive teacher moves, they were each part of the teacher's plan for the lesson, and thus, are not the types of instances that are important for a teacher to notice during instruction. During the project meetings, instances such as these were used to discuss the difference between good planned teacher moves and moments that require a teacher response during a lesson.

On the other hand, in the same video, the researchers noted a mathematically important moment while students were playing a dice-rolling game related to probability that the participants did not. In the game, students placed 18 chips in columns numbered zero through six and then removed a chip each time the difference of two rolled dice was equal to the column number; the winner was the first to remove all 18 chips. After playing the game and recording the differences of the dice on each roll in a frequency table, the teacher told his students that they would play again. A number of students placed their chips by copying the outcomes in the frequency table in hopes of winning the game the next time, not realizing that the same outcome was unlikely. Although this moment had the potential to be used to highlight important ideas about theoretical and experimental probability, neither participant noticed its mathematical importance.

By the eighth video, both participants had shifted their primary focus from the teacher's actions to the thinking of students in the classroom, although Mary was generally better able to discern important student thinking from that which was less important than was Audrey. For example, both participants coded an instance in which a student used the distance formula to find

the distance between some pairs of coordinate points, but used simple subtraction of coordinates for other pairs that were located vertically or horizontally from one another on the coordinate plane. Most students in the class had used the distance formula for all pairs of points. Both participants recognized this as an opportunity to highlight when the distance formula needed to be used, and when other methods were appropriate. Similarly, both coded an instance in which a student had included an unnecessary step in a geometric proof and another student explained why the step was not needed. Audrey, however, also coded an instance in which students were guessing which angles in a figure were supplementary to one another. Although supplementary angles are an important topic in geometry, there was no mathematical basis for their guesses, so it would be difficult to use the guessing to support student understanding.

Participant Perspectives on Learning

In the post-interviews, both participants agreed that the project activities were a valuable addition to their student teaching experience, despite the extra time they required. Both stated that coding the videos and then using the merged Studiocode timelines as a basis for project meeting discussions helped them really think about what moments during the lesson were mathematically important; instances on which they agreed confirmed their thinking, and those about which they disagreed pushed them to explain their thinking and continually refine their definition of what moments were mathematically important. Both participants also agreed that leaving *mathematically important moment* ill-defined at the start and then developing and refining the definition together made them think hard about what moments might meet the mathematically important criteria and which might not. They both stated that introducing the researcher's conceptualization of the construct via a reading (Author reference) mid-way through the project was helpful in that it gave them a framework to use to make sense of the work they had already done.

When asked to discuss how they felt the project activities affected their teaching, both participants noted that it shifted their focus from themselves to their students. Audrey said that, "It was good because it helped me key in onto the student a little bit more than I would have otherwise. Cause I would have been just trying to get, like, the content out there." Mary said that analyzing the videos helped her become more objective about her teaching, noting that it was important that the focus wasn't on "am I a good teacher, am I a bad teacher" but was on the mathematically important moments and how they could be used in the lesson. This, she said, helped her focus "on what [students] are learning rather than on 'Oh shoot, I should have done that.'" Mary also noted that she often thought about how to set up mathematically important moments when planning lessons. She said that she focuses on "trying get them to come up with things and asking them why more. I want to put a lot on them. And like, I already wanted to do that as a teacher, but I think this helped me think about it more, like, when I'm in class." Later in the interview she added, "You can, like, set [a moment] up and it might not happen, but it's more likely to happen if you if you set it up than if you don't."

Interestingly, both participants also noted that the activities helped them to think about the other non-mathematics classes they were teaching. Mary said that it helped her ask better questions in her chemistry class, where she noted that she had started out asking mainly lower-level questions. Audrey said, "I think [coding and discussing the video] helped me respond to those moments [in math], but then I feel like, why aren't we doing this in science, cause I don't know what those moments are in science. You know what I mean, the scientifically important moments. It's like, in science, I'm like what, I think I'm kind of struggling a bit with what is the

big picture." Although not an expected outcome of the activities, this type of transfer is particularly encouraging to improving instruction more broadly.

Discussion and Conclusion

Preliminary findings suggest the value of engaging prospective teachers in detailed, focused analysis of practice as part of the student teaching experience. Both the participants' video coding and their interviews indicate that engaging in the project activities helped keep them focused on what matters the most during instruction—listening to student thinking and assessing the mathematical potential of that thinking in order to determine whether it might be worthwhile to incorporate. This is a very different focus than what has been documented in many student teaching experiences, where prospective teachers' primary focus is on issues, such as classroom management, that have little connection to mathematical content or to students' understanding of it (Leatham & Peterson, 2010).

The use of video analysis software seemed to support teacher learning by forcing them to identify specific moments and their reasons for selecting them as mathematically important prior to discussing them with others. Although the coding could have been done in other ways—for instance, on paper by noting video time stamps—Studiocode allowed the researcher to merge the participants' timelines in order to display their coding together and also to quickly select a coded moment and replay the instance in the video during a project meeting. These features of the software allowed for focused discussion of particular coded moments in ways that other modes of coding and reflection could not.

The discussions in which the researcher and participants engaged seemed critical to helping the participants learn to differentiate between moments that had significant mathematical potential and those that did not. In the discussions, the researcher pushed the participants to clearly articulate the mathematical importance of coded moments; when they could not, they were engaged in discussions about whether the moment was, in fact, mathematically important. Discussing instances that the participants had not coded provided an opportunity to help them better understand secondary school mathematics and to begin to make connections among mathematical ideas. Thus, although time-consuming, the sustained interactions with the researcher/teacher educator seemed critical to supporting participant learning. This study suggests, as have others (e.g., Grossman, et al., 2009), that teacher educators need to find ways to keep field experiences, particularly extended experiences such as student teaching, focused on students' learning of mathematics. Understanding what facilitator moves and tools are most productive in doing so will help teacher educators plan activities that most effectively and efficiently advance teacher learning.

Although the results of this work appear promising, there is much work to be done. Thus far, the data indicates that the activities supported learning, but does not illuminate the specifics of how that learning occurred. Subsequent data analysis will aim to draw connections between changes in participants' noticing and specific learning activities. This will entail detailed analysis of the questions the researcher asked to push participant thinking during project meetings, questions the participants raised during the meetings, and how specific tools and frameworks may have supported participant noticing. It is expected that this analysis will lead to hypotheses about teachers' learning-to-notice trajectories and specific learning events that might trigger advances in teachers' noticing. In future projects, the teacher education model will be refined and tested with larger groups of student teachers in a range of mathematics classrooms, and additional data will be collected to understand how the noticing skills that teachers develop affect

their classroom instruction.

The preliminary results of this study provide support for including research-like video analysis in teacher education programs as a means of advancing teachers' ability to learn from practice. Developing teachers' abilities to notice and capitalize on important instructional events holds great promise in positioning teachers to become life-long learners in their own classrooms, and thus, improve their instruction over time.

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